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Quebec Region

Canadian Science Advisory Secretariat
Science Response 2016/043

UPDATE TO THE PROPORTION OF EASTERN HUDSON BAY BELUGA HARVESTED AND IMPLICATIONS FOR HARVEST ALLOCATIONS IN NUNAVIK

Context

Hunters living in northern Quebec (Nunavik) and in the community of Sanikiluaq on the Belcher Islands (Nunavut) harvest beluga whales (*Delphinapterus leucas*) from a mix of the Eastern Hudson Bay (EHB) stock and Western Hudson Bay (WHB) beluga stock. The WHB stock is composed of one or more other stocks that have been grouped together until additional stock identification studies are completed (Fig. 1).

The subsistence harvest of beluga whales in Nunavik is managed under a three-year management plan (April 24, 2014–January 31, 2017) via a combination of area closures (Little Whale, Nastapoka and Mucalic River estuaries) and a Total Allowable Take (TAT) established by the Nunavik Marine Region Wildlife Board (NMRWB)(Fig. 1). In Sanikiluaq (Nunavut), there are no restrictions on the total number of beluga whales that can be taken, but the municipality has voluntarily closed their beluga harvest from 15 July to 30 September each year, as a conservation measure to protect animals belonging to the EHB beluga stock.

Using a population model fitted to a series of aerial survey estimates, DFO Science provided advice that a maximum reported harvest of 180 EHB belugas would respect the management plan`s objective that the probability of an EHB population decline not exceed 50% (DFO 2014). At that time, genetic research suggested that Sanikiluaq hunters would land 18 EHB beluga whales over three years, and the TAT was set at 162 EHB whales within the Nunavik Marine Region. All estimates take into account animals that are struck, but not recovered and presumed dead (Struck and Lost). As a result, a combined landed catch of 180 EHB belugas was anticipated to be taken by Nunavik and Sanikiluaq hunters over the course of the management plan.

Recently, new information has been published on the estimated proportion of EHB beluga whales taken by hunters in the Nunavik and Sanikiluaq subsistence harvests (DFO 2016). Based on this new information, Makivik Corporation (`Makivik`) submitted a proposal to the NMRWB requesting that the existing Nunavik TAT for EHB belugas be modified, arguing that it is likely that the number of EHB belugas in the landed catch in Sanikiluaq is lower than what was assumed when the management plan for the Nunavik Marine Region was established.

Fisheries and Oceans Canada (DFO) Ecosystem and Fisheries Management has asked DFO Science for advice about how this new information on the proportion of EHB belugas taken in the different areas, will affect our understanding of current harvest levels of EHB beluga and if the changes requested by Makivik will have an impact on the overall sustainable harvest of EHB belugas in Nunavik authorized under the current TAT.

This Science Response Report results from the Science Response Process of June 3, 2016 on the Update for the Eastern Hudson Bay Beluga Proportions Harvested.

Background

The beluga is a toothed whale with pan-Arctic distribution extending into the Hudson Bay complex in sub-arctic eastern Canada (Richard and Pike 1993). Subsistence hunting of beluga by Nunavik Inuit is directed towards a migratory population that summers in Hudson Bay and winters in Hudson Strait and the Labrador Sea. Photo-identification, satellite telemetry and genetic studies have shown that beluga exhibit strong seasonal site fidelity to specific congregation areas during summer (de March and Postma 2003; Doniol-Valcroze et al. 2016). Despite interbreeding on wintering grounds (Turgeon et al. 2012), cultural conservatism of maternally-transmitted migration routes limits exchange between these summering aggregations (Colbeck et al. 2012), thus making beluga vulnerable to local extirpations. This cumulative evidence has led to the current use of discrete summering stocks as management units (e.g., Richard and Pike 1993).

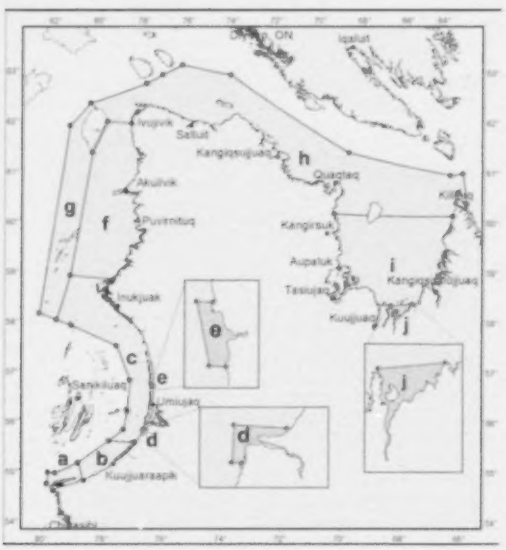

Figure 1. Map of Nunavik communities and boundaries of hunting areas in the 2014–2017 beluga management plan. Areas in red (Little Whale (d),Nastapoka (e), and Mucalic (j) Rivers) are closed to hunting.

Most summer aggregations of beluga across the Canadian Arctic are genetically differentiated (de March and Postma 2003). In eastern Canada, the EHB stock is differentiated from the adjacent Western Hudson Bay (WHB) stock or stocks, based on mitochondrial DNA analyses, although these stocks belong to the same breeding population (de March and Postma 2003; Turgeon et al. 2012). EHB beluga currently number around 3,300 animals (Doniol-Valcroze et al. 2016), and were designated as Endangered in May 2004 (COSEWIC 2004).

Belugas also frequent the area around the Belcher Islands (within the Nunavut Settlement Area) from early in spring and throughout summer and fall, where they are harvested by hunters from the community of Sanikiluaq. The relationship of the beluga whales observed around the Belcher Islands to other summer stocks is unclear. Satellite telemetry studies have shown that EHB beluga may be vulnerable to harvesting in the Belcher Islands, especially in summer and fall (Doniol-Valcroze and Hammill 2012), but previous genetic analyses suggest that few EHB beluga are taken during Sanikiluaq spring and fall hunts. There is no formal management plan

or legal harvest restriction for Nunavut hunters living in the Belcher Islands. However, the community of Sanikiluaq has enacted beluga hunting rules, involving a voluntary annual closure of the summer beluga harvest in the Belcher Islands (between July 15 and September 30) as a conservation measure.

In 2014, a 3-year management plan approved by the NMRWB established a TAT for the EHB stock, which relies on genetic analyses of samples obtained from Inuit hunters to determine the proportion of EHB beluga harvested seasonally in different areas of Nunavik. The plan's management objective accepts a TAT that would result in a 50% probability that the population would not decline. A population model estimated that this would allow a total landed harvest of 180 EHB beluga whales. When the management plan was developed, it was assumed that 12% of the belugas harvested by hunters in Sanikiluaq belonged to the EHB stock and that Sanikiluaq hunters would not remove more than a total of 18 EHB whales, while Nunavik hunters were to take no more than 162 EHB whales over the three years.

Based upon 1,254 skin samples provided by hunters from their beluga whale harvest to DFO collected from 1982 to 2013, the proportion of EHB animals harvested in different areas were updated and results were grouped according to the new beluga management boundaries established by the NMRWB (Doniol-Valcroze et al. 2016; DFO 2016). The updated information indicated that the proportion of EHB beluga whales taken in the Ungava Bay spring hunt declined from the 10% used in the plan to 8.8%, while the proportion in the Hudson Strait spring hunt increased from the 10% used in the plan to 11.7%, and from 20% to 23.6% in the Hudson Strait fall hunt (Tables 1 and 2). The proportion of EHB animals taken in the eastern Hudson Bay hunt remained unchanged, while sample sizes for the spring north-eastern Hudson Bay and the fall Ungava Bay hunts were insufficient for inference. Consequently, the harvest proportions of EHB belugas remain unchanged for these areas (Tables 1 and 2).

Table 1. Harvest regions and seasons, total harvest and the estimated proportion (%) and total number of EHB beluga taken as per the current Nunavik Marine Region Management Plan for beluga. () is estimated number of EHB whales removed, rounded to the nearest whole whale. [1]the harvest statistics round down, for whale fractions less than 0.5.

Year	Ungava Bay		Hudson Strait		North East Hudson Bay		Eastern Hudson Bay	Long Island & James Bay	Ottawa Islands	**Total Nunavik**
	Spring	Fall	Spring/ Summer	Fall	Spring/ Summer	Fall				
	10%	**40%**	**10%**	**20%**	**40%**	**30%**	**100%**	**0%**	**20%**	
2015 Harvest	28	3	106	94	0	30	36	6	0	303
EHB	2.8	1.2	10.6	18.8	0	9	36	0	0	78.4 (78)[1]
2014 Harvest	11		208	37	1	14	22	5	0	298
EHB	1.1		20.8	7.4	0.4	4.2	22	0	0	55.9 (56)
Total Harvest	**39**	**3**	**314**	**131**	**1**	**44**	**58**	**11**		**601**
Total EHB	3.9	1.2	31.4	26.2	0.4	13.2	58	0		134.3 (134)[1]

The updated proportion of EHB beluga harvested by hunters from Sanikiluaq in the Belcher Islands was 2.8% in spring (April 1 – June 30), and 6.5% if spring was extended by two weeks

(April 1 – July 14). The proportions were 30.6% in summer (July 1 – September 30) and 0% in fall (September 1-November 30).

Table 2. Nunavik harvest regions and seasons and updated estimated proportion of EHB beluga taken in each region/season (%), total number of beluga reported harvested and estimated number of EHB beluga harvested have been updated with the new proportions from DFO (2016). Proportions in Ungava Bay in the fall and northeast Hudson Bay in the spring/summer were unchanged from the management plan as there were insufficient samples to provide meaningful estimates. [1] the harvest statistics rounded to the entire whale e.g. 83.3 rounds to 84 animals.

Year	Ungava Bay		Hudson Strait		Northeastern Hudson Bay		Eastern Hudson Bay	Long Island & James Bay	Ottawa Islands	**Total Nunavik**
	Spring	Fall	Spring/ Summer	Fall	Spring/ Summer	Fall				
	8.8%	**40%**	**11.7%**	**23.6%**	**40%**	**33.2%**	**100%**	**0%**	**20%**	
2015 Harvest	28	3	106	94	0	30	36	6	0	303
EHB	2.5	1.2	12.4	22.2	0	9	36	0	0	83.3 (84)[1]
2014 Harvest	11		208	37	1	14	22	5	0	298
EHB	1.0		24.3	8.7	0.4	4.2	22	0	0	60.6 (61)
Total Harvest	**39**	**3**	**314**	**131**	**1**	**44**	**58**	**11**		**601**
Total EHB	3.5	1.2	36.7	30.9	0	13.2	58	0		143.9 (145)

Analysis and Response

Analysis by Makivik

Sanikiluaq harvest

The following analysis was submitted by Makivik using beluga harvest data from Sanikiluaq (Table 3). The mean annual beluga harvest in the Belcher Islands for the last six years is 69 (SE=21.6) belugas.

Table 3. Reported beluga harvests (2010–2015) reported by Sanikiluaq hunters, hunting in the vicinity of the Belcher Islands (DFO unpublished data).

Year	Reported Landed Catch
2010	47
2011	32
2012	61
2013	76
2014	26
2015	170

Sanikiluaq hunters provide a skin sample from animals that they have harvested as part of a DFO sampling program. Data obtained from DFO indicate that samples were obtained from 95 beluga whales, out of a total of 196 beluga reported harvested between April 1, 2014 and March

31, 2016; a period that roughly corresponds to the first two years of the current management regime. Makivik used the same seasonal breakdowns as DFO (2016): spring (April 1-June 30), summer (July 1-August 31), and fall (September 1-November 30), but used July 1-July 15 instead of the extended spring of April 1-July 14) in DFO (2016). Of the 95 Sanikiluaq beluga samples collected during 2014-2015, 79 were taken during the spring (April 1 to June 30), one was from July 1–15, and the remaining 15 were taken in the fall between September 1–November 30 (Table 4).

Makivik assumed that the seasonal distribution of the skin samples collected in Sanikiluaq represents the seasonal distribution of the entire Sanikiluaq beluga harvest. This is in-line with the harvesting effort reported by representatives of the Sanikiluaq Hunters and Trappers Organization (L. Arragutainaq, pers. comm. to Makivik Corporation)(Table 4). In 2014 and 2015, hunters from Sanikiluaq reported harvesting a total of 196 beluga whales (Table 3). If the seasonal distribution of the skin samples represents the seasonal distribution of the entire hunt, then 83% of the whales are harvested between April 1-June 30, one percent are harvested between July 1-15, 16% between September 15 and November 30 (Table 4). Applying these proportions means that 163, 2 and 31 beluga whales were harvested during April 1-June 30, July 1-15, and September 15-November 30 respectively (Table 4). Makivik also assumed that EHB animals comprise 2.8% of the April 1–June 30 harvest, and 6.5% of the July 1–15 harvest. This results in a total of 4.6 EHB beluga whales harvested between April 1-June 30, and 0.1 beluga whales harvested between July 1-15, for a total EHB harvest of 4.7 (rounded to 5 whales) during 2014 and 2015 (Table 4). For the 2016 season, Makivik assumed that the reported harvest in Sanikiluaq from 2014 and 2015 represented 2/3 of the total three year harvest for the community i.e. the 2016 reported harvest would be 98 whales. If the 2016 harvest is 98 whales, and the seasonal pattern is the same as in 2014 and 2015, then the estimated total number of EHB belugas harvested by Sanikiluaq hunters would be (4.7 + 2.3) = 7 animals over the life of the 2014-2017 management plan, not the 18 animals as originally assumed. Makivik concluded that from this analysis that an additional (18-7=11) 11 EHB beluga whales are available for re-assignment to Nunavik hunters, without compromising the management plan objectives that the probability of a decline in the EHB population is not greater than 50%.

Table 4. Table provided by Makivik in their analysis of the beluga whale harvest in Sanikiluaq. Estimated seasonal breakdown of reported beluga harvest from Sanikiluaq, assuming that the distribution of harvest effort is the same as the proportion of sample kits returned by hunters, and the estimated total number of belugas harvested. The proportion of EHB beluga in the harvest is taken from DFO (2016).

	April 1-June 30	July 1-July 15	September 15-November 30	Total
Beluga samples	79	1	15	95
Seasonal distribution of harvest (proportion)	0.83	0.01	0.16	1
Total harvest	163	2	31	196
Proportion EHB	0.028	0.065	0	
Total EHB (2014-2015)	4.6	0.1	0	4.7

Analysis by DFO

When the management plan was developed it was assumed that 12% of the Sanikiluaq harvest comprised EHB belugas and that Sanikiluaq hunters would remove a total of 18 EHB belugas.

To date, 196 beluga whales have been reported landed in Sanikiluaq in 2014 and 2015 (Table 3). Assuming that 12% of these are EHB beluga whales, the total number of EHB beluga landed would be 24.

DFO (2016) indicated that for April 1 to June 30 harvests, the mean proportion of EHB belugas in the harvest was 2.8%, but this proportion rose to 6.5% when analysed as an extended spring (April 1 to July 14). The proportion increased further to 30.6% for animals harvested between July 1 and August 31. Based on the reported 2014 and 2015 harvests and assuming that the seasonal distribution of the overall harvest is the same as the distribution of the skin sampling program, then 83% of the animals are harvested between April 1 to June 30 harvests, and 2.8% of these are EHB beluga whales. However, if 1% of the whales are harvested between July 1-15, then it is more appropriate to assume that the proportion of EHB whales in the harvest is 30.6%. Applying these proportions results in a 2014-2015 harvest of (5.2 belugas rounded to 6, because it is not possible to have a fraction of a beluga) 6 EHB beluga whales (Table 5).

Table 5. Analysis by DFO of estimated number of EHB beluga whales harvested by Sanikiluaq in 2014 and 2015. A total of 196 beluga whales were reported harvested during the first two years of the Nunavik management plan. Doniol-Valcroze et al (2016) used a date period of September 1 to November 30, but there were very few samples from early September.

N=196 beluga whales	April 1-June 30	July 1-July 15	September 1-November 30
Seasonal distribution of harvest (proportion)	0.83	0.01	0.16
Total harvest by season	163	2	31
Proportion EHB	0.028	0.31	0
Total EHB	4.6	0.6	0
Rounded total	5	1	0

The community of Sanikiluaq has adopted a voluntary summer closure (July 15 to September 30) to reduce the probability of removing EHB belugas. The analysis by DFO (2016) suggests that this seasonal closure is quite effective in protecting EHB belugas.

The seasonal distribution of reported harvests in 2014 and 2015 assumed that harvest effort was the same as the seasonal distribution of the skin samples obtained for DFO. However, the 2016 harvest for Sanikiluaq is not known. Since Sanikiluaq has no harvest restriction, it is not possible to place an upper limit on the potential harvest, nor when animals will be taken, which could have an impact on the whether the management plan objectives will be respected. Two harvest scenarios were examined, although multiple scenarios are possible. In both scenarios, it was assumed that 84% of the belugas harvested in Sanikiluaq were landed between April 1 and July 15. The proportion of EHB animals in the harvest was assumed to be 6.5% (DFO 2016). In one scenario 26 beluga whales were reported landed; in the second scenario 170 beluga whales were reported landed. These represent reported harvest levels in Sanikiluaq from 2014 and 2015 respectively, which coincidently are the highest and lowest reported harvests over a six year period (Table 3). For reported harvests of 26 to 170 beluga whales, the total number of EHB beluga whales landed in Sanikiluaq in 2016, would be 2 to 10 belugas (Table 6). Adding in the estimated 6 EHB beluga whales removed in 2014-2015 in Sanikiluaq, results in removal estimates of 8 to 16 EHB belugas over the life of the plan (Tables 5 and 6).

Table 6. Estimated number of EHB beluga whales landed in Sanikiluaq in 2016, for two harvest scenarios. It was assumed that 84% of the animals would be landed between April 1 and July 15, 2016 and that EHB whales comprised 6.5% of the landed harvest. One scenario assumed a total harvest of 26 whales landed, and a second scenario assumed a total harvest of 170 whales landed.

	Minimum Harvest Scenario	Maximum Harvest Scenario
April 1-July 15	N=26	N=170
Seasonal distribution of harvest (proportion)	0.84	0.84
Total harvest by season	21.8	142.8
Proportion EHB	0.065	0.065
Total EHB	1.4	9.3
Rounded total	2	10

Nunavik harvest

The total number of whales reported harvested by hunters in Nunavik during 2014-2015 was 601 beluga whales. Using the proportions of EHB beluga whales in the harvests that were applied when the management plan was established, DFO estimates that the number of EHB whales landed is 56 and 78 belugas for 2014 and 2015 respectively, for a total of 134 EHB beluga whales landed (Table 1). If the statistics are updated using the new proportions, the total number of EHB whales removed is actually 61 and 84 EHB whales in 2014 and 2015 respectively for a total of 145 (Table 2). This leaves 17 EHB belugas available for harvesting in 2016.

Table 7. Estimated number of EHB beluga whales removed by hunters in Sanikiluaq (Nunavut) and Nunavik based on proportions of EHB beluga harvested when the Nunavik management plan was developed and the updated proportions given in DFO (2016). When the plan was developed it was assumed that Sanikiluaq would remove 12 EHB whales in 2014-2015, and an additional 6 animals in 2016. [1]Based on reported harvests and assuming that 12% of the animals harvested were EHB whales. [2]Based on estimated removal of EHB belugas in 2014-2015 (see Table 5) and assuming for 2016 that 6.5% of the Sanikiluaq harvest comprises EHB belugas, with total reported harvest scenarios of 26 or 170 belugas (see Table 6).

	Assumed Sanikiluaq harvest when plan developed	Estimated EHB removals using original proportions when plan established		Estimated EHB removals using the updated proportions (DFO 2016)	
		Sanikiluaq[1]	Nunavik	Sanikiluaq[2]	Nunavik
2014-2015	12	24	134	6	145
2016	6		28	2-10	17
Total EHB animals harvested	18		162	8-16	162

To summarize, using new information from DFO (2016) on the proportion of EHB animals in the Sanikiluaq harvest, Makivik proposed that the 11 'unused' EHB whales from the Sanikiluaq harvest be transferred to Nunavik and added to the 28 EHB belugas that are available to be killed in 2016. This would allow Nunavik hunters to exceed their TAT of 162 whales, but the overall removal would likely remain below 180 EHB whales identified as the management objective.

An analysis by DFO of the proportion of EHB belugas in the harvests of both Sankiluaq and Nunavik was completed. Applying the updated proportions from DFO (2016), the estimated number of EHB belugas taken by hunters around the Belcher Islands declines from 24 to 6 EHB beluga whales being removed during 2014-2015 (Tables 5 and 7). Under two different scenarios, another 2-10 EHB belugas could be removed during the 2016 hunt, resulting in a total of 8-16 EHB belugas landed over the period of 2014-2016 (Tables 6 and 7). This leaves (18-16=2; 18-8=10), 2-10 EHB belugas that could be 'allocated' to Nunavik hunters in 2016.

However, using the new information from DFO (2016), the estimated number of EHB belugas harvested during the 2014-2015 Nunavik hunt increases from 134 to 145 EHB belugas leaving only (162-145=17) 17 belugas (not 28 EHB belugas as thought using the 'old' proportion information) available to Nunavik hunters during the 2016 season if the TAT is to be respected (Tables 2 and 7).

Adding the 2-10 EHB belugas 'available' from Sanikiluaq to the 17 EHB belugas, that are available to Nunavik hunters results in a 2016 TAT of (17+2=19; 17+10=27) 19-27 EHB belugas versus a TAT of 28 EHB belugas if the plan is not reopened. Overall, reopening the plan offers no benefit to Nunavik hunters.

Conclusions

The proportion of EHB beluga whales taken in the Sanikiluaq and Nunavik hunts varies temporally and spatially. The subsistence harvest of beluga whales in Sanikiluaq (Nunavut) is not regulated, but the harvest in Nunavik is managed under a management plan established by the Nunavik Marine Region Wildlife Board (NMRWB), that ends January 31, 2017. When the management plan was established, it was assumed that Sanikiluaq hunters would not remove more than 18 EHB beluga whales over three years. Based on this, the NMRWB established a TAT of 162 EHB beluga whales for Nunavik hunters.

In 2016, new information on the proportion of EHB beluga whales in harvests from different areas in Nunavik and in Sanikiluaq was published (DFO 2016). Using this new information, Makivik submitted an analysis of the estimated proportion of EHB beluga whales harvested by hunters in Sanikiluaq and concluded that fewer EHB belugas were harvested there, than was assumed when the plan was established. Consequently, an analysis completed by Makivik proposed that 11 more EHB beluga whales could be allocated to hunters in Nunavik.

However, if the management plan is to be re-opened, then the estimated number of EHB beluga whales harvested in all areas, including Nunavik and the Belcher Islands needs to be re-examined.

Updating the proportion of EHB animals in the 2014-2015 Sanikiluaq harvest, and using two different scenarios for the 2016 harvest results in an estimated 8-16 EHB belugas being removed by Sanikiluaq hunters during the management plan (Table 7). This leaves 2-10 EHB belugas that could be 'allocated' to hunters in Nunavik.

Updating the proportion of EHB animals removed by hunters in Nunavik increases the number of EHB animals harvested during the first two years of the plan to 145 animals leaving only (162-145=17) 17 EHB animals available to harvest in the final year of the management plan.

Previous advice from DFO Science concluded that the population could sustain an overall removal of 180 EHB belugas (DFO 2014). This advice took into account harvesting in Sanikiluaq and Nunavik. If the Nunavik management plan is re-opened, then the new estimates for the Nunavik and expected Sanikiluaq harvests indicate that as many as 27 EHB belugas could be harvested by Nunavik hunters if the overall management objective is to be respected, although given the uncertainty in the Sanikiluaq harvest a revised TAT of 19 EHB animals for Nunavik, would be more precautionary. If the plan is not re-opened, then the TAT remaining for Nunavik hunters in 2016 is 28 EHB belugas. This analysis shows that there is no gain in harvest for Nunavik hunters by opening the plan.

Uncertainty in the expected Sanikiluaq harvest was examined using two very different assumptions for total landings of 26 and 170 belugas in 2016. However, uncertainty in the proportion of EHB whales in the harvest was not examined. For example the mean proportion of EHB belugas harvested by Sanikiluaq during the extended spring hunt is 6.5%. However, the 95% confidence limits for this proportion lie between 2% and 13.3% indicating that the actual number of EHB animals in the 2016 Sanikiluaq harvest could be much higher (DFO 2016). To improve estimates of the number of EHB beluga whales landed in this area, more information on harvest date and location, and samples for genetic analyses are needed.

The management framework for Nunavik beluga is very complicated. The overall management objective is to estimate a harvest level that has a probability of a population decline of 50%, which is a high risk management strategy. Given the variable proportions of EHB beluga taken in each area, the sophisticated system of seasonal/geographical allocation of harvests is also high risk. For this small depleted population, this means that there is a 50% probability that the actual proportion of EHB animals harvested is higher than predicted. A more risk adverse harvesting framework would better contribute to recovery of this Endangered stock.

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